

C & C TECHNOLOGIES, INC.

A TECHNICAL REPORT

on

PHASE 2: SEA LION CONFIGURATION

for

NRL CONTRACT N00014-94-C-6005

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<p>Sea Lion #1 has been mechanically reconfigured and refurbished in order to make the vehicle sea worthy and capable of meeting NRL's needs as a research and development platform. The hull has been extended by 16 inches and the electronics bay modified to improve payload capacity. These modifications included the lowering of the fore planes and splitting the fuel into two compartments. The nose cone was also modified for easy access and removal for sensor installation and maintenance. Additional modifications were made to the hull to accommodate the Brooks Ocean launch and retrieval system.</p> <p>Sea Lion #1 was also electrically refurbished in order to insure the vehicle is fully functional and operationally sound. Some sensors were upgraded and the entire electrical system checked, refurbished and calibrated.</p>			
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GENERAL

Sea Lion #1 has been mechanically reconfigured and refurbished in order to make the vehicle sea worthy and capable of meeting NRL's needs as a research and development platform. The hull has been extended by 16 inches and the electronics bay modified to improve payload capacity. These modifications included the lowering of the fore planes and splitting the fuel into two compartments. The nose cone was also modified for easy access and removal for sensor installation and maintenance. Additional modifications were made to the hull to accommodate the Brooks Ocean launch and retrieval system.

Sea Lion #1 was also electrically refurbished in order to insure the vehicle is fully functional and operationally sound. Some sensors were upgraded and the entire electrical system checked, refurbished and calibrated.

MECHANICAL

The key points in the hull modification to the Sea Lions were, increasing the electronics payload capacity, extending mission endurance through added fuel capacity, and fitting for the Brooks Ocean launch and retrieval lifting points.

C & C Technologies in co-operation with GEO Resources engineered changes to the existing Sea Lion hull which were reviewed and approved by NRL. The Sea Lion's new mission parameters would require the removal, and fabrication of a redesigned forward hull section. The Sea Lions forward hull configuration had two major design deficiencies, a large but limited electronics space, with no heat sinking surfaces, and the forward dive planes and fuel tanks encompassing the entire hull, preventing forward extension of the electronics space. The new design divides the forward hull section horizontally with the upper half dedicated to electronics bay and lower section housing the fuel tanks and dive planes. (See Figure 1)

Upon design approval the hull was stripped of all electronic and hydraulic systems, engine removed for over haul and all subsystems removed for inspection and testing. The Sea Lion body was transported to Bollinger Ship Yard, Lockport Louisiana, where the hull was cut in half, 10.5" forward of the electronics bay/engine room bulkhead. A reconfigured section was rolled from 3/16" 6061 aluminum plate, cut to a length of 8'-1 1/2", and welded to the aft hull. The new section would house a 36 sq. ft. electronics bay, a net volume gain of 12.3 sq.ft over the old Sea Lion's electronics bay. The new electronics bay has a drop step directly forward of the engine room/electronics bay bulkhead designed to house the existing Robertson SKR-82 Gyro Compass. The computer control box rests just above the gyro (See Figure 2). This location takes advantage of existing cable configurations and minimizes antenna cable lengths. A 5/8" thick aluminum floor plate 63" x 34" extends from this point forward to the ballast chamber bulkhead. This plate separates the fuel tanks from the electronics bay. It also functions as a heat sink for the electronics bay due to its large mass, and the under side is open to sea water through the fuel tanks. In the event of a hatch leak, a 2" wide drip tray surrounds the electronics bay floor

for the water to pool. The drip tray routes water to the electronics bilge area which pumps into the engine room. (See figure 3)

The modifications to the forward hull section increased the vehicle length by 1'-4", to a total of 25'-4". These modifications and intended electronics payload shifted the theoretical center of gravity forward 10", now located 16' from the stern tube. To implement the Brooks Ocean launch and retrieval lifting davits, the snorkel mast was relocated forward of it's old position and centered on the engine room/electronics bay bulkhead. Centering the mast on the bulkhead provided the necessary strength member for securing the forward lifting point. A second davit is incorporated on the aft engine room/ballast chamber bulkhead and protrudes through the sub's shell. The lifting points and dedicated lifting sling were certified at Bollinger ship yard to 1.5 times the gross vehicle weight of 7200 lbs. Sand bags and steel blocks were positioned in the sub to simulate the intended electronics payload not present at time of certification.

The fuel system is divided into two interconnected saddle tanks, bisected by the forward dive planes, each tank has a volume of approximately 8 cu.ft.. This provides a fuel capacity of 116 gallons, an increase of 14 gallons. The fuel is contained in water tight bladders mounted inside the saddle tanks. Each tank is open to sea water through penetrations in the hull, this configuration maintains head pressure on the fuel while the vehicle is submerged. The fuel bladders were manufactured by Western Trading Co. of Slidell, LA. The new bladders were installed in the Sea Lions using the existing hardware. A small fuel leak was detected (seepage). It was determined that the material on the new fuel bags did not allow a proper seal with the existing hardware. New hardware was fabricated with larger flanges, increased bolt hole pattern, embossed flanges, and O-rings. (See Figures 4,5 and 6)

Guide pins, dog assemblies, and gasket faces were added to the nose cone and forward edge of the new hull section, so that the nose can be removed as needed. Four cubic feet of syntactic foam was added to the nose cone for permanent buoyancy. This flotation gives a net buoyancy gain of 145 lbs. This was necessary to offset the forward movement of the center of gravity.

A hinged knuckle was incorporated into the snorkel mast 28" from the base of the mast. This knuckle allows the mast to be lowered while remaining secured to the vehicle during transportation. This eliminates the requirement to remove the mast for transportation. (See figure 7)

The engine cooling system was changed from the existing sea water intake system to a closed loop system featuring external keel coolers manufactured by Fernstrum Inc. of Menominee, Michigan. This closed system allows the vehicles engine and subsequent sub systems to be exercised out of the water for periods of up to 45 minutes without over heating. The Sabres header tank, water pump and plumbing hoses were changed to accommodate the new keel coolers.

With the removal of the 440 Hz alternator, a large area of the engine room bulkhead was left available. The air system for the vents and blow were relocated here for ease of maintenance.

Geo-Resources informed us that their Dolphins were experiencing problems with the exhaust system clapper valve spring failure. This was due to excessive heat in the exhaust system. We located ENGINEERED SPRING, an engineering firm specializing in spring design and production. Information supplied by CSS concerning exhaust system temperature along with sample springs currently used were sent to the firm. They engineered a spring that fits within the current valve housing and is rated at the present working temperatures experienced by the CSS Dolphins at significantly less cost. The cost for sixteen springs was \$476.96, or \$29.81 each. The original manufacturers price was quoted at \$184.14 each.

ELECTRICAL

Very few changes were necessary during the electrical refurbishment. The attitude sensor was replaced because the mean time between failure was about 500 hours. A Watson Industries, Inc., ADS-C232-1A, Displacement/Rate Sensor replaced the old attitude sensor. The new sensor has a mean time between failure rate in excess of 50,000 hours. (See schematic at figure 8).

C & C Technologies engineered and built a belly pack for the Sea Lion. The belly Pack is necessary for safe maneuvering of the vehicle during launch and recovery operations. (See schematic at figure 9).

A relay was added to the control circuitry to turn the strobe light on and off. Software provisions were available but no control circuitry existed to implement the software commands for strobe on and off. (See schematic at figure 10).

EQUIPMENT REQUIRING REPLACEMENT

ENGINE

Spare parts for the Sabre engine currently in the Sea Lion are no longer available in the United States. All spares must come from the United Kingdom. This significantly increases the lead time and cost of spare or replacement cost. Additionally, when the supply of spares remaining in the United Kingdom are exhausted there will be no spares available. There are some companies working on developing after market parts. We do not recommend the use of these after market parts because of quality and fit. The following price comparisons are provided for your information.

SABRE

671 GM

<u>PART</u>	<u>COST</u>	<u>LEAD TIME</u>	<u>COST</u>	<u>LEAD TIME</u>
head gasket	\$152	10 days	\$47	none/same day
rings	\$437	10 days	\$257	next day
water pump	\$201	21 days	\$142	on hand

The cost of a new engine is approximately \$11,500.00, as quoted for a Detroit Diesel 4-53T. This engine meets the horse power, fuel economy and size requirements of the Sea Lion.

CONTROL ELECTRONICS/SOFTWARE

Logistical support for the existing electronic control system is very difficult. The software is written specifically to address boards that are no longer manufactured. Refurbished parts were located and procured to bring the Sea Lion to operational status. However, the availability of compatible hardware is very questionable in the near future. The control software is not portable to computer hardware currently produced.

The Sun workstation that will be installed in the Sea Lion to integrate and control the sensors and telemetry systems could also handle the vehicle control functions. Software can be developed to work on the topside Sun workstation for vehicle control. This would increase the electronics payload capacity by eliminating much of the hardware required on the vessel. This would also have the added benefit of readily available spares, (off the shelf), and access to source code.

PART SOURCE: See attachment 1.

ENGINE PARTS REPLACED: See attachment 2.

RECOMMENDED SPARE PARTS LIST: See attachment 3.

PREDIVE CHECKLIST: See attachment 4.

HYDROGRAPHIC PREDIVE CHECKLIST: See attachment 5.

PART SOURCE

<u>PART NAME</u>	<u>PRICE</u>	<u>SOURCE</u>
DIVE PLANE BUMPERS	\$75.00 each	AMERICAN MOLD SERVICES 440 Industrial Parkway, Unit 8 Lafayette, Louisiana 70503-3365 Ph# (318) 233-6565 800-787-6653 Contact; Clement J. Cornay
HULL MODIFICATION		BOLLINGER SHIP YARD P.O. Box 250 Lockport, Louisiana 70374-0250 Ph# (504) 532-2554 Contact; Cliff Bonvillan
HIGH PRESSURE HYDRAULIC FILTERS original Pall filter #HH9021A12UPSWB Replacement Filter Part# PX 921-B3	\$110.00 each	PX FILTRATION 1004 Business Pkwy Dallas, Texas 75084 Ph# (214) 470-9894
*LOCAL DISTRIBUTER		CRANFORD EQUIPMENT S.E. Evangeline Thruway Broussard, Louisiana Ph# (318) 837-1871
EXHAUST CLAPPER SPRINGS	\$25.00 each	ENGINEERED SPRINGS 9881 Tanner Road Houston, Texas 77041 Ph# (713) 690-0391 Contact; Tom Upton

ALTERNATOR REPAIR

HAROLD & CASTIEL
Admiral Doyal
New Iberia, Louisiana
Ph# (318) 364-8248

NEW ELECTRODYNE ALTERNATOR
model # GE100-24LCM \$1300.00 each

ELECTRODYNE, INC.
Pleasant Hill Road
Scarborough, ME 04074
Ph# (207) 883-4121
800-341-0242

ORCA PARTS

I.S.E. RESEARCH
1734 Bradway Street
Port Coquitlam, B.C. Canada
U3C 2M8
Ph# (604) 942-5223

KEEL COOLERS \$3400.00 each

R.W. FERNSTRUM, INC.
Menominee, Mich 49858
Ph# (318) 365-3679

***LOCAL DISTRIBUTOR**

MID-SOUTH BOAT
2804 East Hwy. 90
New Iberia, Louisiana 70560
Ph# (318) 365-3679

SABRE ENGINE PARTS

NORTHEAST FORD ENGINE
56 Mitchel Road
Ipswich, Maine 01938
Ph# (508)356-2114
Contact; Chip

FUEL CELLS (bags only) \$550.00 set (2)

WESTERN TRADING CO.
Slidel, Louisiana (plant)
Ph# (504) 343-1222
Contact; Steve Gauthreaux

ATTITUDE SENSORS p/n # ADS C232-1A	\$2480.00 each	WATSON INDUSTRIES, INC. 3041 Melby Road Eau Claire, WI 54703 Ph# (715) 839- 0628
SYNTACTIC FOAM, type2 p/n #	\$175.00 per cu. ft. (4 cu. ft. per sub)	FLOATATION TECHNOLOGIES P.O. Box 1171 Biddeford, ME 04005 Ph# (207) 282-7749
DATA RADIOS/MODEMS p/n # DR 4800B2	\$5050.00 each (U.S.)	DATA RADIO, INC. 5500 Royalmount, #200 Montreal, Canada H4P 1H7 Ph# (514) 737-0020
DEPTH SENSORS p/n #BF, 15 psia, 24vdc	\$660.00 each	DATA INSTRUMENTS 100 Discovery Way Acton, MA. 01720 Ph# (508) 264-9550
OVER DEPTH SWITCH (2 part) comutator switch #PA31A replacement #PA31B	\$104.00 each	ASCO SWITCH 50-60 Hanover Florhan Park, N.J. 07932 Ph# (201) 966-2000
PRESSURE SWITCH # RE 30A44	\$98.50 each	
*LOCAL ASCO DISTRIBUTOR		MOODY PRICE Baton Rouge, Louisiana Ph # (504) 344-0511
BALLAST BLOW SOLENOID/VALVE p/n #8211 C11 replacement # EF 8210G11	\$246.00 each	ASCO SWITCH 50-60 Hanover Florhan Park, N.J. 07932 Ph# (201) 966-2000

MAST SOLENOID, model # SDG \$180.00 each
p/n # SA-1834-24

SYNCHRO START, INC.
6250 W. Howard
St. Niles, ILL. 60642
Ph# (708) 967-7730

THROTTLE SOLENOID, model # 1504
p/n # 24C6U1B281 \$45.50 each

SYNCHRO START
6250 W. Howard
St. Niles, ILL. 60642
Ph# (708) 967-7730

10 A CIRCUIT BREAKER \$4.90 each
p/n # 30055-10

COLE HERSEE
20 Old Colony Ave.
South Boston, MA. 02127
Ph# (617) 268-2100

***LOCAL DISTRIBUTOR**

PRESSURE SENDING UNITS \$225.00 each
p/n # PX303-2KG5V

GUIDRY'S IGNITION SERVICE
New Iberia, Louisiana
Ph# (318) 365-7471

OMEGA ENGINEERING
One Omega Dr., Box 4047
Stamford, CT. 06907
Ph# (203) 359-7874

ELECTRICAL CONNECTORS \$400.00 each
p/n # 5507-3221-0004

BURTON, INC.
111 Maryland St.
El Segundo, CA. 90245
Ph# (310) 322-0615

D.C. AMP METER \$275.00 each
p/n# IA 5025P

F.W. BELL , INC.
6120 Hanging Moss Rd.
Orlando, FL. 32807
Ph# (407) 678-690

HYDRAULIC FITTINGS & HOSES

3/16" fitting #3908-03544	\$31.00 each
3/8" fitting #3908-06548	\$71.00 each
3/16" hose @	\$1.12 ft.
3/8" hose @	\$2.40 ft.

SYNFLEX

10585 Main St.
Mantua, OH. 44255
Ph# 1-800-837-1467

***LOCAL DISTRIBUTOR**

AL GEORGE, INC.
HWY. 90 E.
Lafayette, Louisiana
Ph# (318) 233-0626

HYDRAULIC PUMP \$740.00
p/n # PV 86 RSY 20 CV1

SPERRY/VICKERS
5353 Highland Dr.
Jackson, Miss. 39206
Ph # (601) 981-2811

ENGINE PARTS REPLACED

SOURCE- NORTHEAST FORD ENGINES, INC.
(508)356-2114

PART #/DESCRIPTION	QTY
66890-HUB	1
49038-PUMP-WATER	1
36240-SENDER	1
36252-GAUGE	1
66891-PULLEY-SPLIT	2
57259-BOLT	4
59010-WASHER	4
49038-PUMP-WATER	1
50031-GASKET	1
11130-SCREW-SET	5
59004-WASHER	5
58105-SCREW-SET	3
59003-WASHER	3
14050-HOUSING	1
15480-PIPE	1
15372-PIPE	1

50030-GASKER-THERMOSTAT	1
66894-PULLEY	1
58049-SCREW	3
40169-BELT	3
15482-PIPE	1
40505-SWITCH	1
11710-CAP-7 PSI	1
50130-GASKET CAP	1
59061-WASHER- 3/8	3
57374-BOLT- 3/8	1
16127-HOSE- REDUCER	1
16120-HOSE	1
16165-HOSE	1
16123-HOSE	1
16153-HOSE	1
13745-HOSE-END	2
13746-HOSE- BRAIDED	1
13084-ADAPTER	1
10072-TANK-HEADER	1
59002-WASHER-8MM	2
58065-SCREW-SET	2
12114-BRACKET	1

57254-SCREW-SET	2
57257-SCREW-SET	1
12113-BRACKET	1
65074-SCREW	4
59060-WASHER	4
66892-SPACER	10
31000-HOSE-5/16 ID PVC	1
15395-CLIP	1
57252-SCREW-SET	1
55232-NUT	1
59060-WASHER	5
57259-BOLT	3
55381-NUT	2
59061-WASHER-3/8	4
57357-SCREW-SET	2
59010-WASHER	6
66719-O-RING	1
194-155-SERVICE MANUAL	2

ORCA SPARES LIST

The following list is what is deemed necessary to take as spares on a deployment.

ENGINE

<u>-sending units</u>	<u>Sabre part#</u>
--oil pressure	# 11832
--oil low pressure by-pass	# 36180
--engine temperature, water	# 36192
--engine over temperature	# 11905
--excess fuel, temperature	# 40505
--solenoid switch 24v	# 40570
Turbo	# 66803
gasket set	complete
water pump	complete
starter 24v.CA24-G24-55M	# 40020
fuel pump	# 46499
fuel filters	# 46503
oil filter	# 46547
thermostat	# 11057

transmission fluid, Dextron 2
engine oil (turbo diesel)
assorted hoses
belts A50-Matched set (Gates)
MDB 925AC (Master Parts)
coolant
Alternator 24v-100 amp, Model # GE100-24LCM (Electrodyne)
24 volt, 70 amp battery charger (Newmar)
12 v battery charger
12 v marine battery
assorted exhaust gasket material
Wix # 33166
exhaust clapper springs
Permatex high temperature gasket sealer
Starting fluid (cold weather)
battery terminals

Air compressor (Jordair)
compressor oil, Teresstic 150 (Exxon)

drive belts # V80, 13C 1815 A69 Matched set (Gates)

VEHICLE BODY

lifting sling w/shackles
nose cone gaskets
electronics bay gasket
engine room gasket
silicone grease to lubricate gaskets
s.s. hatch dog bolts
with spacers, nuts, and rollpins
Spare mast
O-rings for knuckle, Parker # 256
mast fairing
upper mast covers
forestay with fairing
spare dive planes-forward & aft
dive plane bumpers
spare rudder
propellers
propeller shaft
exhaust pipe cowlings
sump cover
stuffing box

MISC

contact cleaner
electrical insulating grease
silicone sealant
Locktite 515 gasket eliminator
assorted stainless hardware
Helicoil thread repair kits
cable termination supplies
Scotch coat
Scotch 33 electrical tape
Scotch 133 splicing tape
assorted heat shrink
heat gun
potting compound
100-300 watt soldering gun
20- 50 watt soldering iron

HYDRAULICS AND AIR SYSTEM

hydraulic pump, part # PV 86 RSY 20 CV1 (Vickers)
3/8 Synflex hose
3/8 Synflex female reusable fittings
3/16 Synflex female reusable fittings
3/16 Synflex female reusable fittings
High pressure oil filter, part # px 921-A3 (PX Filtration)
Bank valve solenoids, part # 211-157, (Atchey Controls)
Bank control valve, part # DG4V3 6C WH12, p/n 468483 (Vickers)
hydraulic cylinder, complete
55 gallons hydraulic oil
air vent body gaskets (I.S.E.)
high pressure air feedback sensor (Omega)
low pressure air feedback sensor (Omega)
spare gauges, 0-500 psi., 0-5000 psi.
O-ring kit
O-ring splicing kit
assorted JIC fittings
assorted pushlock fittings
assorted JIC plugs & caps
teflon tape
oil absorbent pads
clean box of rags

ELECTRICAL

depth sensor	# BF ,range 15 psia, 24 vdc (Data Instruments)
over depth switch,	# PA31A (ASCO Switch)
DC current sensor	# IA 5025P (F.W. Bell)
circuit breakers	# 30055-10 (Cole Hersee)
mast valve solenoid	# SDG, part # 24C6U1B281, 24vdc (Syncro Start)
throttle solenoid	# SDG, part # SA-1834-24, 24vdc (Syncro Start)
hall effect sensors,	
magnet assemblies	(I.S.E.)
gyro boards	(Robertson)
set of connectors	
antennas w/cables,	

ELECTRONICS

Spares List

Description	Manufacturer	Part Number	Quantity	Source
Computer Equipment				
Computer Board	MPL AG	MPL 4220-1-96	1	Gespac
Computer Board	Gespac	GESADA-1A	1	Gespac
Computer Board	Gespac	GESMPU-14	1	Gespac
Computer Board	MPL AG	MPL 4205-1-96	1	Gespac
Computer Board	Gespac	GESMEM-12BC	1	Gespac
Computer Board	Gespac	GESICC-1S	1	Gespac
Computer Board	Gespac	GESCIO-1B	1	Gespac
Computer Board	Gespac	GESPIA-2A	1	Gespac
Computer Board	Gespac	GESICU-2A	1	Gespac
Data Acquisition Board	Data Translations	DT28081	1	Data Translations
Video Driver Board	AST Research	AST-3G Plus	2	PC Service Source
RAM Board	AST Research	P286 FASTRAM	2	PC Service Source

attachment 3

Mother Board	AST Research	P286 Main	1	PC Service Source
Data Acquisition Board	Scientific Solutions	Base Board - 2000025	1	JACO Electronics
EPROM	AMD	AM27C256-150 DC	6	Newark Electronics
EPROM	AMD	AM27C128-150 DC	4	Newark Electronics
RAM	Motorola	MCM6206DP20	8	Newark Electronics

Power Supplies			
DC - DC Converter	Vicor	VI-210-CW	1
DC - DC Converter	Vicor	VI-B10-CW	1
DC - DC Converter	Vicor	VI-211-CX	2
DC - DC Converter	Vicor	VI-2W2-CV	1
DC - DC Converter	Vicor	VI-213-CW	1
Converter Filter	Vicor	VI-RAM-C1	1
Computer Power Supply	Kepco	RDT 001-AA-24	1
HV Power Supply	Ultravolt	1/8 A24-P20-C	1
Relays			
Time Delay Relay	Potter & Brumfield	CHD-38-30011	1
Control Relay	Potter & Brumfield	KRPA 11 DG24	2
Time Delay Relay	Potter & Brumfield	CDD-38-30012	1
DC Power Relay	Stancor	70-903	2
Control Relay	T-Bar	801-12C12	1
Operators Control Console			
Monitor - EGA/CGA	Princeton	HX12E	1
			Ultimate Display

		Connectors			
Underwater	Marshall	26-5MC62	3	3	Fowler Resources
Underwater	Marshall	26-5FC62	3	3	Fowler Resources
Underwater	Marshall	46-5MC	3	3	Fowler Resources
Underwater	Marshall	46-5FC	3	3	Fowler Resources
Underwater	Marshall	46-5MCO	3	3	Fowler Resources
Underwater	Marshall	46-5FCO	3	3	Fowler Resources
Underwater	Marshall	66-5MC	3	3	Fowler Resources
Underwater	Marshall	66-5FC	3	3	Fowler Resources
Underwater	Marshall	86-5MC	3	3	Fowler Resources
Underwater	Marshall	86-5FC	3	3	Fowler Resources
Ribbon Cable	3M	3425-6000	2	2	Newark Electronics
Ribbon Cable	3M	3417-6000	4	4	Newark Electronics
Ribbon Cable	3M	3473-6000	4	4	Newark Electronics
Ribbon Cable	3M	3399-6000	4	4	Newark Electronics
Ribbon Cable	3M	3421-6000	4	4	Newark Electronics
Ribbon Cable	3M	3414-6000	2	2	Newark Electronics
Underwater	Burton	5501-3221-0015	2	2	Burton Elect. Eng.
Circular	Amphenol	MS3102A20-33S	1	1	Newark Electronics

Circular	Amphenol	MS3102A14S-05S	1	"
Circular	Amphenol	MS3102A18-19S	1	"
Circular	Amphenol	MS3102A18-12S	1	"
Circular	Amphenol	MS3106A20-33P	1	"
Circular	Amphenol	MS3106A14S-05P	1	"
Circular	Amphenol	MS3106A18-19P	1	"
Circular	Amphenol	MS3106A18-12P	1	"

Spares List

Description	Manufacturer	Part Number	Quant.	Unit \$	Total \$
Computer Equipment					
Computer Board	MPL AG	MPL 4220-1-96	1	895.00	895.00
Computer Board	Gespac	GESADA-1A	1	925.00	925.00
Computer Board	Gespac	GESMPU-14	1	895.00	895.00
Computer Board	MPL AG	MPL 4205-1-96	1	595.00	595.00
Computer Board	Gespac	GESMEM-12BC	1	425.00	425.00
Computer Board	Gespac	GESICC-1S	1	895.00	895.00
Computer Board	Gespac	GESCIO-1B	1	435.00	435.00
Computer Board	Gespac	GESPIA-2A	1	225.00	225.00
Computer Board	Gespac	GESICU-2A	1	175.00	175.00
Data Acquisition Board	Data Translations	DT2808	1	895.00	895.00
Video Driver Board	AST Research	AST-3G Plus	2	147.00	294.00
RAM Board	AST Research	P286 FASTRAM	2	160.00	320.00
Mother Board	AST Research	P286 Main	1	80.00	80.00
Data Acquisition Board	Scientific Solutions	Base Board - 2000025	1	345.00	345.00
EPROM	AMD	AM27C256-150 DC	6	5.00	30.00
EPROM	AMD	AM27C128-150 DC	4	4.94	19.76
RAM	Motorola	MCM6206DP20	8	10.20	81.60
					0.00

Power Supplies					
DC - DC Converter	Vicor	VI-210-CW	1	160.00	160.00
DC - DC Converter	Vicor	VI-B10-CW	1	144.00	144.00
DC - DC Converter	Vicor	VI-211-CX	2	149.00	298.00
DC - DC Converter	Vicor	VI-2W2-CV	1	205.00	205.00
DC - DC Converter	Vicor	VI-213-CW	1	160.00	160.00
Converter Filter	Vicor	VI-RAM-C1	1	59.00	59.00
Computer Power Supply	Kepco	RDT 001-AA-24	1	534.00	534.00
HV Power Supply	Ultravolt	1/8 A24-P20-C	1	295.00	295.00
				0.00	
Relays					
Time Delay Relay	Potter & Brumfield	CHD-38-30011	1	76.60	76.60
Control Relay	Potter & Brumfield	KRPA 11 DG24	2	17.40	34.80
Time Delay Relay	Potter & Brumfield	CDD-38-30012	1	116.50	116.50
DC Power Relay	Stancor	70-903	2	22.20	44.40
Control Relay	T-Bar	801-12C12	1	116.13	116.13
				0.00	
Operators Control Console					
Monitor - EGA/CGA	Princeton	HX12E	1	375.00	375.00
Keyboard	Cherry Electrical	G81-1800-HAU / 06	1	62.95	62.95
Joystick	Maurey Instruments	SAJ-2723-1CS-502	1	109.53	109.53
Switch	Allen-Bradley	800H-JR2A	1	28.84	28.84

Potentiometer	Allen-Bradley	800H-JR29	1	118.00	118.00
Switch	Allen-Bradley	800H-JR91	1	37.49	37.49
Switch	Augat	MTL 106D	1	7.94	7.94
Switch	Augat	MTL 206P	1	10.79	10.79
Switch	EAO Switch	31-1211-025	2	11.90	23.80
Indicator	EAO Switch	31-040-005	1	3.91	3.91
Radio Equipment					
Arlan 620	Telesystems	200-000787	1	2,500.00	2,500.00
HyperAmp 900	HyperLink Tech.	HyperAmp 900-X	1	598.00	598.00
Arlan Antenna	Maxrad	MFB- 9387	1	180.00	180.00
GPS Receiver	Trimble Navigation	24847-00	1	7,500.00	7,500.00
Compact Dome Ant.	Trimble Navigation	16741-00	1	795.00	795.00
Dataradio Antenna	Maxrad	MFB- 4205	1	113.00	113.00
Connectors					
Underwater	Marshall	26- 5MC62	2	15.00	30.00
Underwater	Marshall	26- 5FC62	2	15.00	30.00
Underwater	Marshall	46- 5MC	2	30.00	60.00
Underwater	Marshall	46- 5FC	2	30.00	60.00
Underwater	Marshall	46- 5MCO	2	28.00	56.00
Underwater	Marshall	46- 5FCO	2	28.00	56.00
Underwater	Marshall	66- 5MC	2	40.00	80.00
Underwater	Marshall	66- 5FC	2	37.00	74.00

Underwater	Marshall	86-5MC	2	49.00	98.00
Underwater	Marshall	86-5FC	2	46.00	92.00
Ribbon Cable	3M	3425-6000	2	8.52	17.04
Ribbon Cable	3M	3417-6000	4	6.82	27.28
Ribbon Cable	3M	3473-6000	4	2.45	9.80
Ribbon Cable	3M	3399-6000	4	4.65	18.60
Ribbon Cable	3M	3421-6000	4	3.60	14.40
Ribbon Cable	3M	3414-6000	2	6.09	12.18
Underwater	Burton	5501-32221-0015	2		0.00
Circular	Amphenol	MS3102A20-33S	1	18.89	18.89
Circular	Amphenol	MS3102A14S-05S	1	10.15	10.15
Circular	Amphenol	MS3102A18-19S	1	15.21	15.21
Circular	Amphenol	MS3102A18-12S	1	12.88	12.88
Circular	Amphenol	MS3106A20-33P	1	28.33	28.33
Circular	Amphenol	MS3106A14S-05P	1	13.56	13.56
Circular	Amphenol	MS3106A18-19P	1	24.80	24.80
Circular	Amphenol	MS3106A18-12P	1	16.36	16.36
				0.00	
				Total	11,427.52

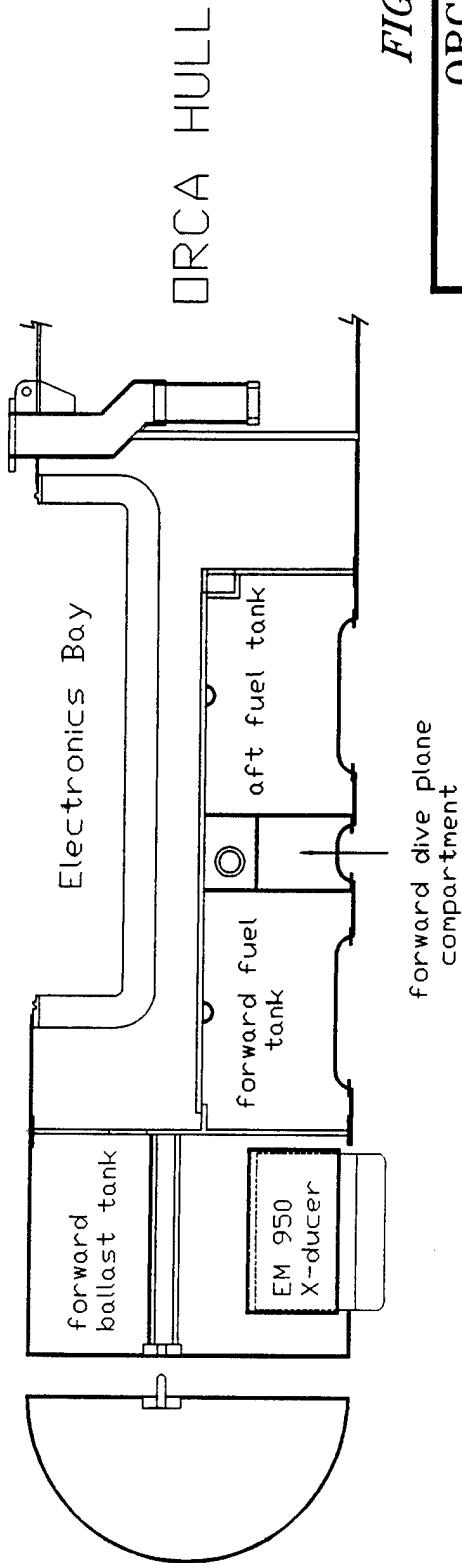
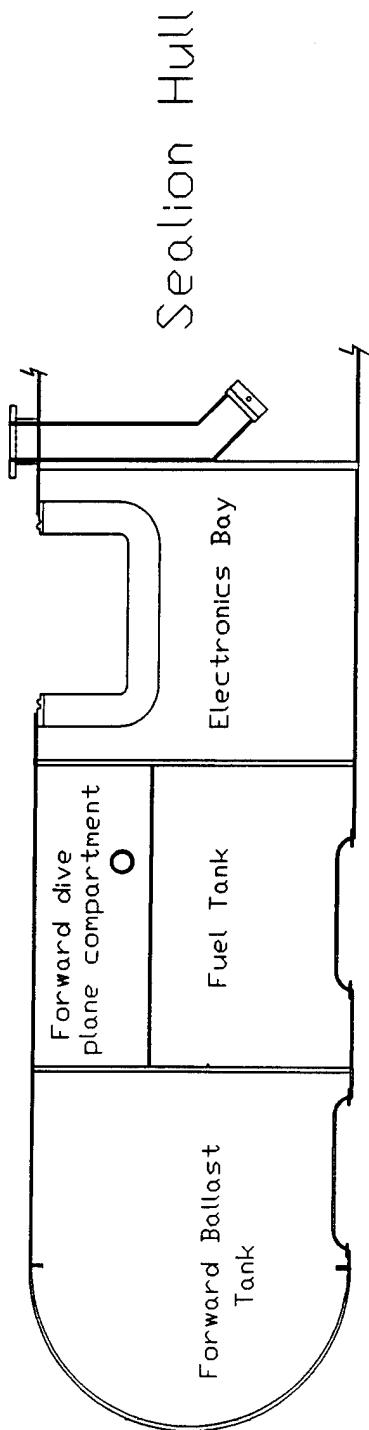


FIGURE 1

**ORCA HULL
MODIFICATIONS**

HULL CONFIGURATIONS

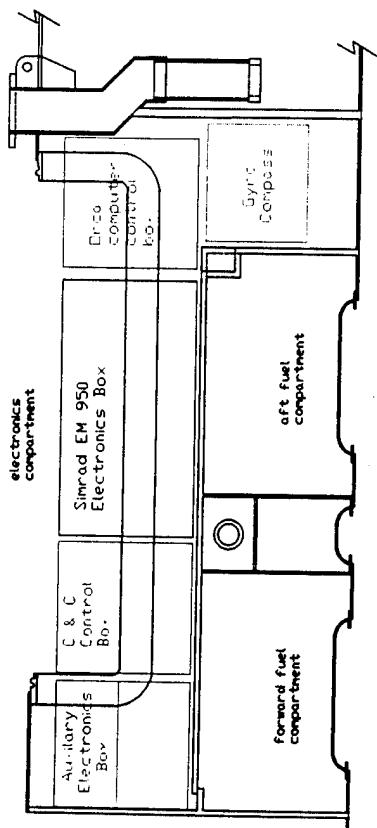
PREPARED BY: C & C TECHNOLOGIES, INC. 600 DOVER BLVD., LAFAYETTE, LA. (318) 861-1442	NRL CONTRACT NO. NO0014-94-C-6005	DATE: 10/12/94
	Dwg:	2SUB

ELECTRONICS PAYLOAD

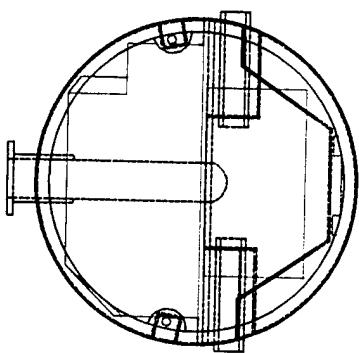
ORCA HULL MODIFICATIONS

FIGURE 2

side view



front view



PREPARED BY: C & C TECHNOLOGIES, INC. 500 DOVER ROAD, LAMBERTVILLE, NJ. (609) 861-1442	NRL CONTRACT NO. N00014-94-C-6005	DATE: 10/12/94
	REV.	REV.
	Dr. g:	PAYLOAD

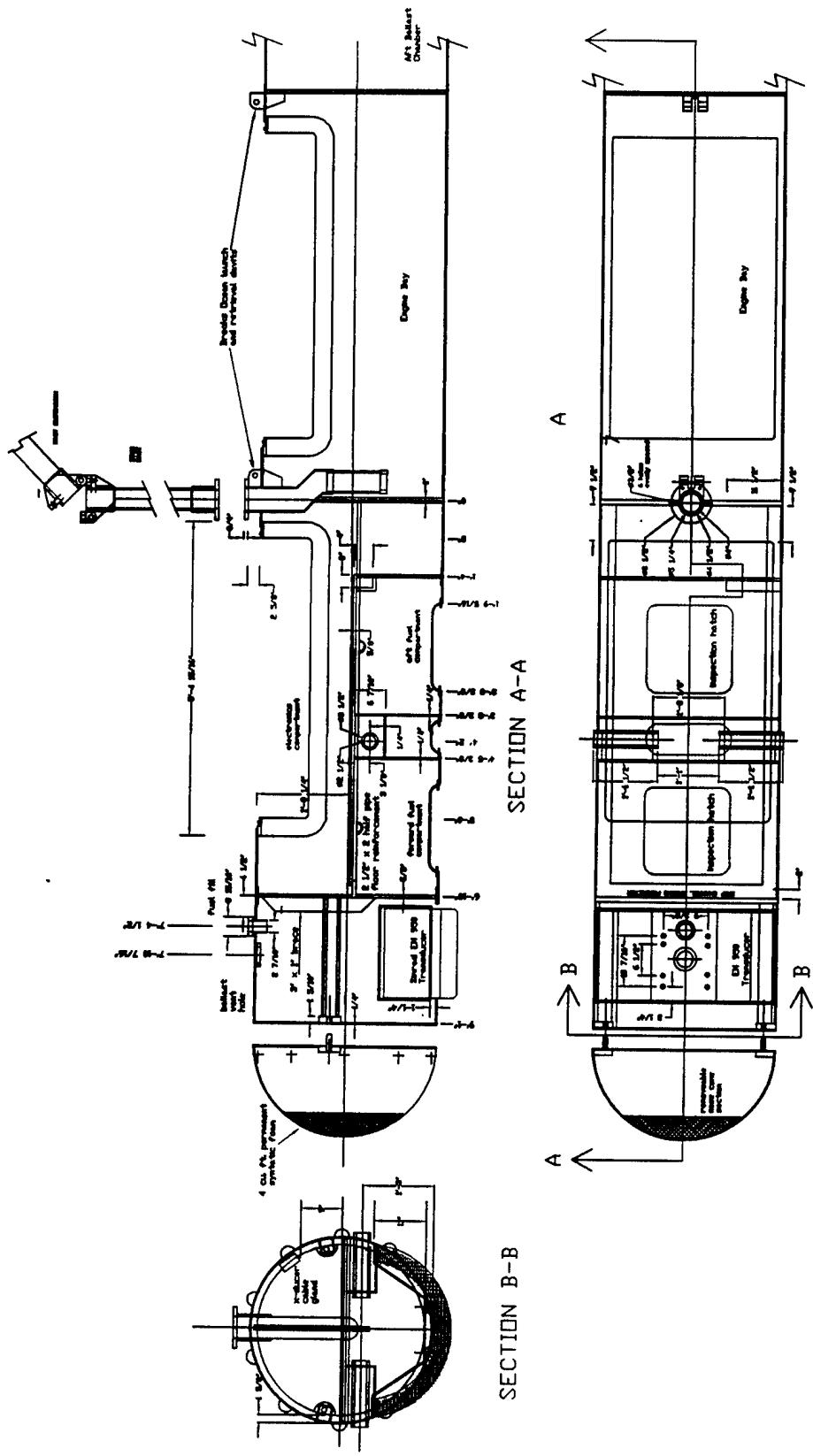


FIGURE 3
ORCA HULL
MODIFICATION

PRE-HELD ENT.	NAME, CONTRACT NO.	DATE: 10/12/94
C & C TRUCKING CO., INC.	100014-94-C-0006	REV.
600 BURKE RD., LANTHROP, WA.		
(425) 561-1422		
	DRUG:	OTC-A

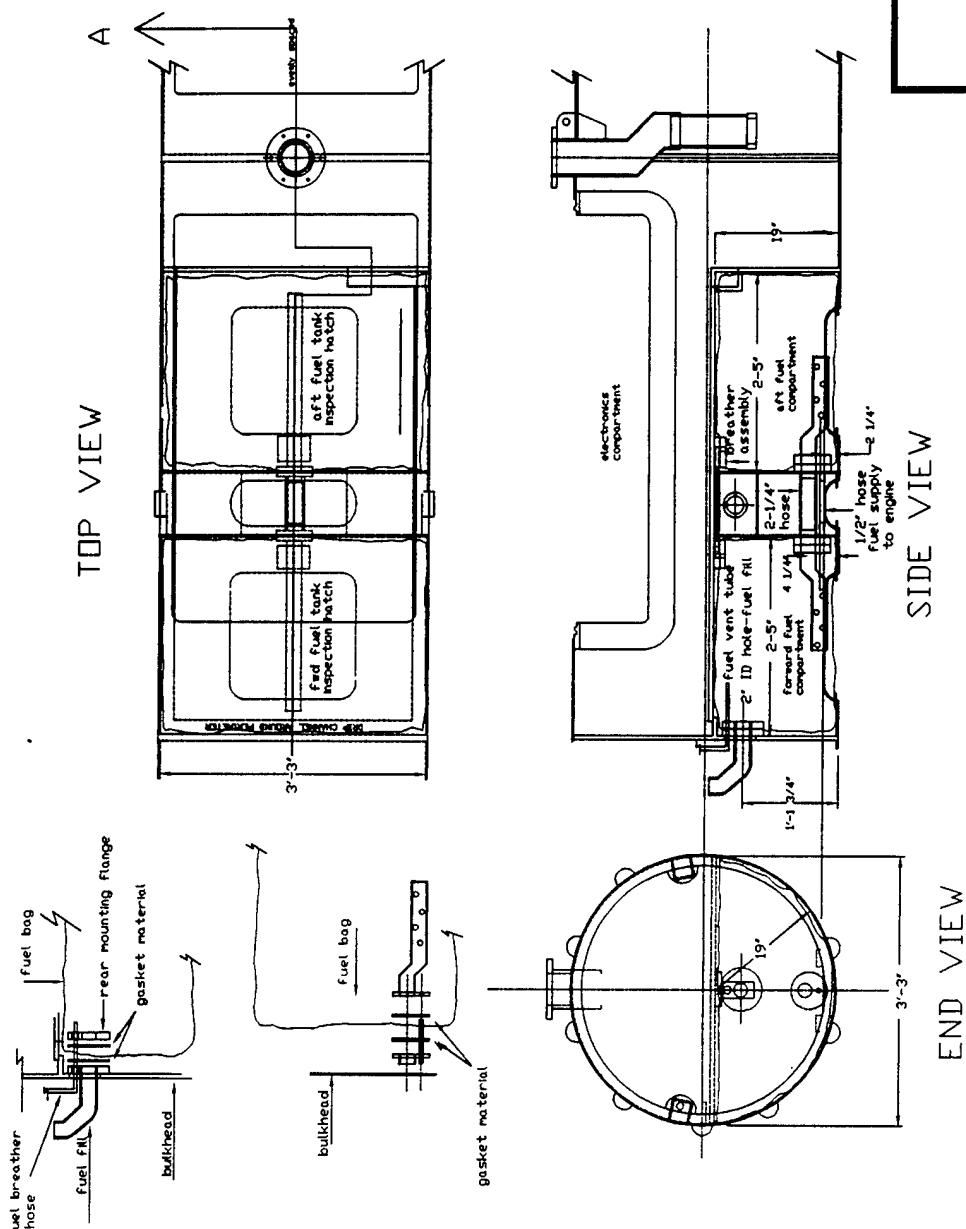


FIGURE 4

ORCA HULL MODIFICATIONS

FUEL SYSTEM

PREPARED BY: **C & C TECHNOLOGIES, INC.**
600 DOVER BLVD., LAFAYETTE, LA.
(318) 981-1442

NRL CONTRACT NO. **NRL0014-94-C-6005**
 DATE: **10/12/94**
 REV. **FUEL**
 Dwg#:

FIGURE 5

ORCA HULL MODIFICATIONS

FUEL CELL HARDWARE

PREPARED BY: **C & C TECHNOLOGIES, INC.**
500 DOVER BLVD., LAFAYETTE, LA.
(318) 981-1442

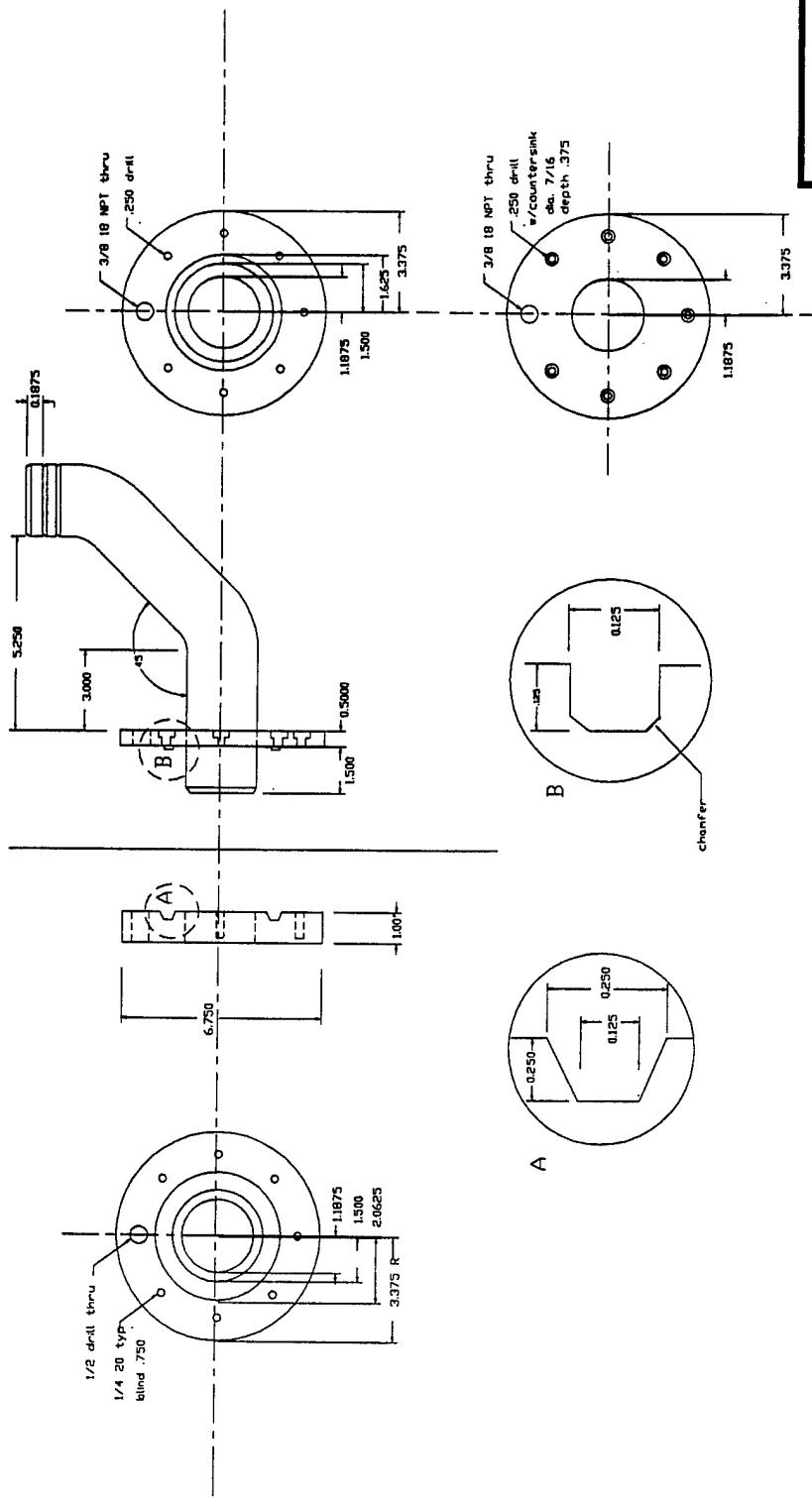
MRL CONTRACT NO.: **MRL0014-94-C-6005**

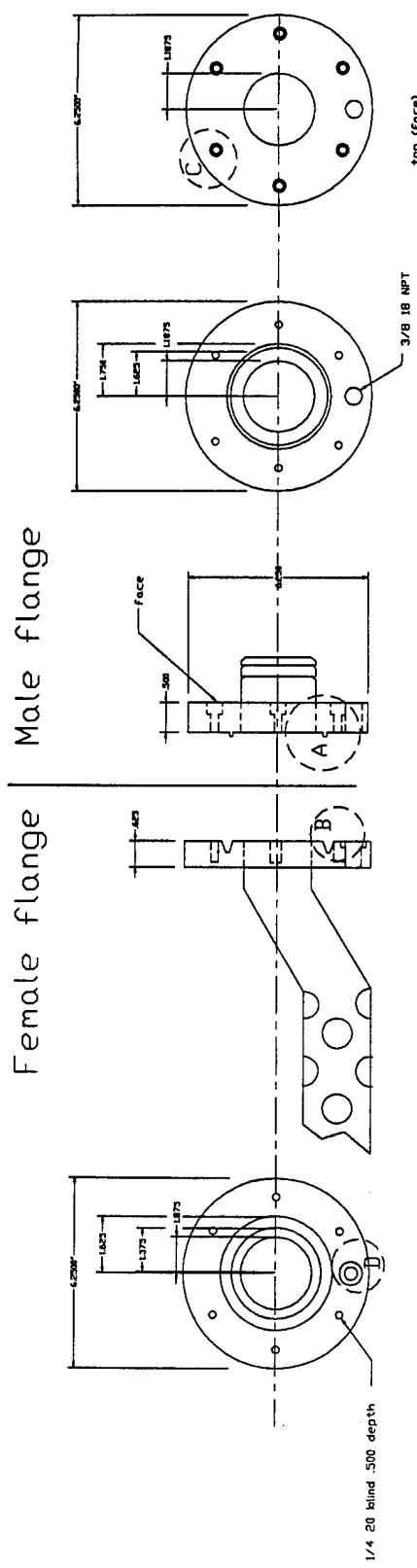
DATE: **10/12/94**

REV.: **FLANGE**

Dwg #: **00001**

Figure 1. Schematic diagram of the male and female flanges of the *Leucaspis* complex.





Fuel Transfer System Notes (1) arrng seat tolerances +/- .002

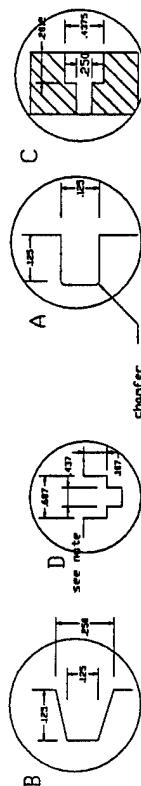


FIGURE 6
**ORCA HULL
MODIFICATIONS**
TO TRANSFER HARDWARE

FUEL TRANSFER HARDWARE

PREPARED BY: **C & C TECHNOLOGIES, INC.**
 500 DOVER BLVD., LAFAYETTE, LA.
 (318) 981-1442

NBL CONTRACT NO. **N00014-94-C-0605**
 DATE: **10/12/94**
 REV. **9**
 DORG: **FUELTRAN**

100

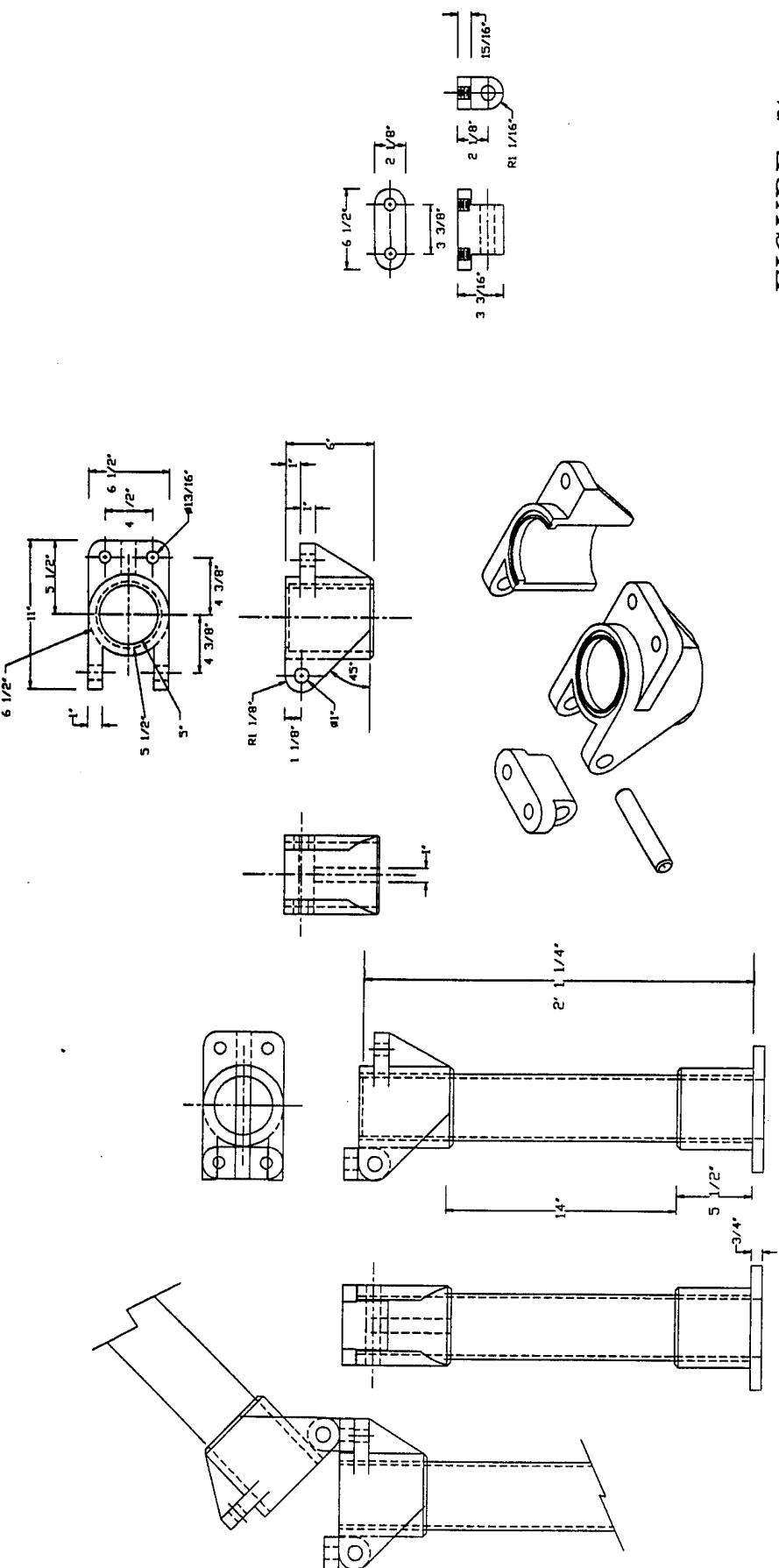


FIGURE 7

ORCA HULL
MODIFICATIONS

KNUCKLE MAST ASSEMBLY

PREPARED BY: C & C TECHNOLOGIES, INC. 500 DOVER BLVD., LAFAYETTE, LA. (318) 931-4442	NRL CONTRACT NO. N00014-94-C-6005	DATE: 10/12/94
	Dwg: STUBMAST	REV.

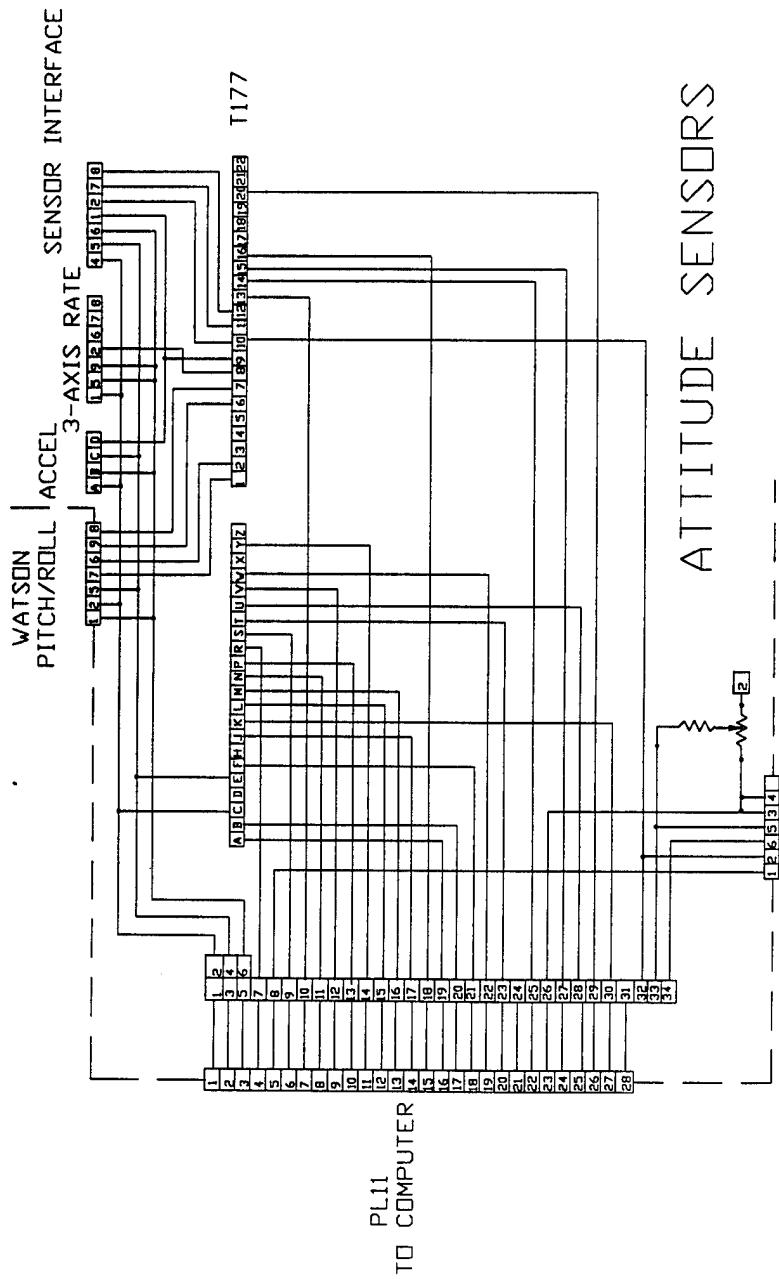


FIGURE 8

ORCA HULL
MODIFICATIONS

ATTITUDE SENSORS

PREPARED BY: C & C TECHNOLOGIES, INC. 500 DOVER BLVD., LAFAYETTE, LA. (318) 981-1442	NRL CONTRACT NO. N00014-94-C-6005	DATE: 10/12/94
	Dwg: SENSORS	REV.

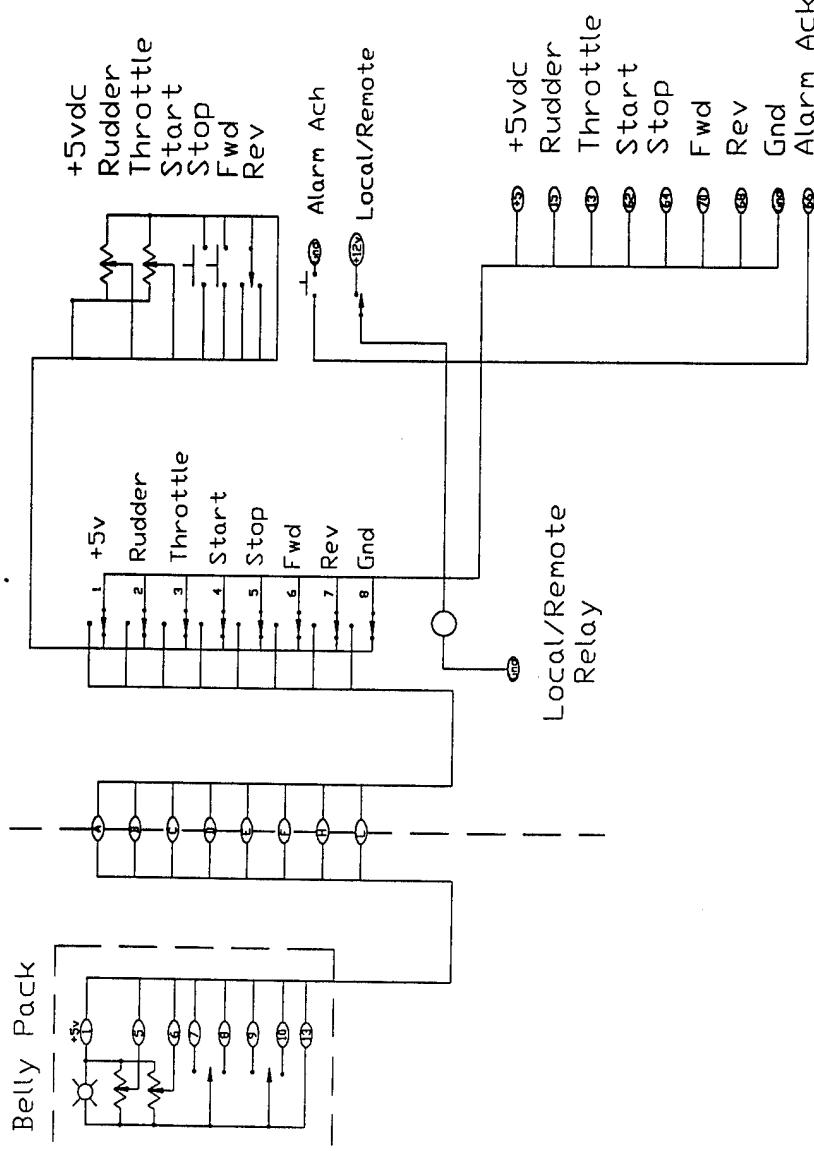


FIGURE 9

ORCA HULL
MODIFICATIONS

BELLYPACK TIE-IN

PREPARED BY: C & C TECHNOLOGIES, INC. 500 DOVER BLVD, LAFAYETTE, LA. (510) 981-1442	NRL CONTRACT NO. N00014-94-C-6005	DATE: 10/12/94 REV.
Dwg: BRACK		

STROBE LIGHT

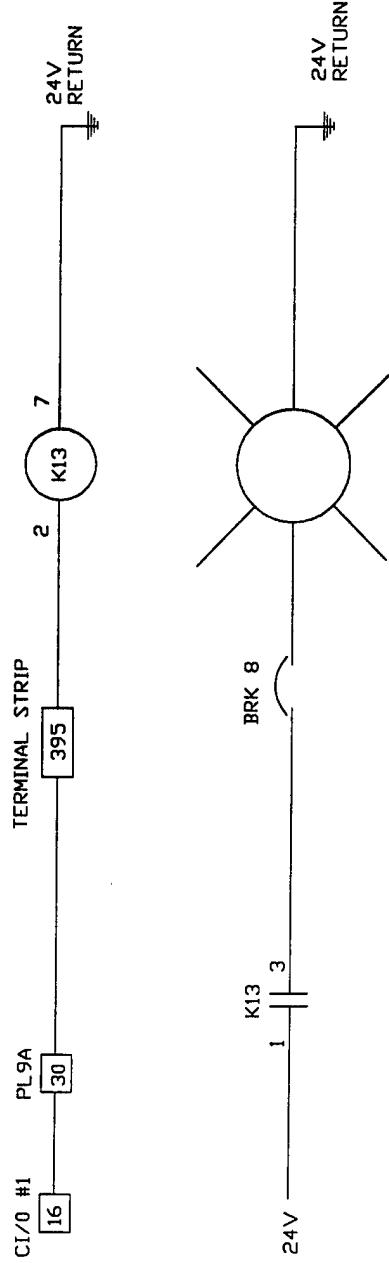
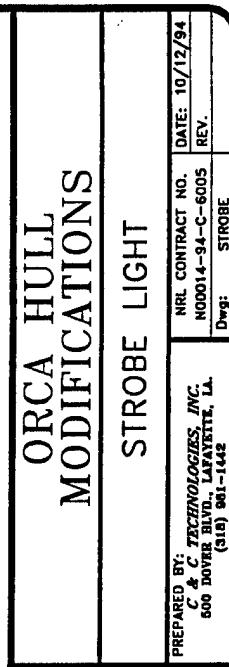


FIGURE 10



ORCA PRE-DIVE, LAUNCH AND POST DIVE CHECKLIST

1-GENERAL VEHICLE CHECKS

NOTE: The following tools and equipment will be essential for the vehicle pre-dive checks:

- 1) 3/4 inch deep socket and ratchet
- 2) 2 ea 9/16 open end wrenchs
- 3) 1-1/8 wrench
- 4) 1 gallon bucket of water, rags, paper towels, silicone grease.
- 5) high pressure air compressor (3000 psi)
- 6) needlenose pliers, phillips screwdriver, flat screwdriver, flashlight
- 7) 8" adjustable wrench and 12" adjustable wrench
- 8) tag lines, life jackets, boat hooks

Consumables such as fuel, engine oil, hydraulic oil, engine coolant, transmission oil, grease, and WD-40 may also be required.

1.1 Start the console:

Ensure Dataradio is on.

Ensure SCC software is started.

1.2 Walk around the vehicle and check for structural damage and loose or missing fasteners in the following areas:

keel
exhaust

mast lower flange, mast hinge, bolts torqued to 150 ft.lbs.
forestay
planes
propeller nut and cotter pin
access hatches
lifting lug welds
fairings

1.3 With the mast in the upright position, make sure that the head valve is free to rotate.

1.4 Open the electronics hatch and check:

hatch coaming and gasket for damage
bulkhead welds and penetrations for leakage
electronics boxes and cables for security
the vehicle antenna is connected and the connections are tight

1.5 Open the engine hatch and check:

hatch coaming and gasket for damage

bulkhead welds and penetrations for leakage

engine oil	_____	added
transmission oil	_____	added
hydraulic oil	_____	added
engine coolant	_____	added

tension of the alternator and the cooling pumps drive belts (less than 1/2" of play)

check propeller shaft packing gland, 3 pumps of grease

fuel filter bowl for water and sediment and valve handle in verticle position

empty fuel overflow bottle

engine hour meter_____

2. PROPULSION CHECKS

(During this time, watch for oil leaks and listen for unusual noises)

2.1 ENGINE

Ensure that the hull switch is on.

Bring vehicle on line from the console. Display the status page.

Check the console for telemetry and clear any alarms.

WARNING: MAKE SURE ALL PERSONNEL ARE CLEAR OF THE PROPELLER, CONTROL PLANES, ENGINE, AND KEEL.

Press the engine START button. Ensure the starter does NOT engage.

Move the throttle to 1000 RPM, depress the hatch safety switch, and push the engine START button on the console until the engine starts. Release the hatch safety switch. The exhaust valve should make a clattering noise.

Clear any console alarms.

Reduce RPM to 1000 and warm engine for 1 to 3 minutes.

Record:	Vehicle	Console	(Range)
engine oil pressure (psi)	_____	_____	30-90
hydraulic oil pressure (psi)	_____	_____	600-1100
engine battery volts	_____	_____	25-29
electronics battery volts	_____	_____	25-29

* **TURN ON GYRO**-- pre-heat 5 minutes.

2.2 PLANES (check that the console display agrees with the actual plane positions)

NOTE: Some walkie-talkies or UHF hand held radios can cause erratic plane behavior when keyed in the vicinity of the vehicle electronics.

2.2.1 Foreplanes

Center the foreplanes (depth set =0, roll set = current roll feedback).

Enter a depth set of 4 meters and check that they go to a full dive position.

Enter a depth set of -4 meters and check that they go to a full rise position.

Center the foreplanes.

Enter a roll set of -25 and check that they go to a full port roll position.

Enter a roll set of +25 and check that they go to a full starboard roll position.

Center the foreplanes.

2.2.2 Aftplanes

Center the aftplanes (pitch set = current pitch feedback).

Enter a pitch set of -25 and check that they go to a full pitch down position.

Enter a pitch set of +25 and check that they go to a full pitch up position.

Center the aftplanes.

2.2.3 Rudder

*Check to see if Gyro is out of pre-heat- if so, slew to sub's current heading.

Set mode to RUDDER (the mode indication on the console will indicate either RUDDER or MANUAL).

Move the joystick to full position and check that the rudder moves to full port.

Move the joystick to full starboard position and check that the rudder moves to full starboard.

Set mode to HEADING (the mode indication on the console will indicate either AUTO or HEADING). note- Left, More, Mode, Heading, ENTER.

Enter a heading set of 30 less than the current heading feedback and check that the rudder moves to port.

Enter a heading set of 30 more than the current heading feedback and check that the rudder moves to starboard.

Set mode to RUDDER

Move joystick to full port position and check that the fudder moves to full port.

Move joystick to full starboard position and check that the rudder moves to full starboard.

2.3 TRANSMISSION (do not leave propeller turning for more than a few seconds)

Reduce throttle to less than 900 RPM. Control computer will not allow you to engage transmission with the RPM above 900.

WARNING: MAKE SURE ALL PERSONNEL ARE CLEAR OF THE PROPELLER, CONTROL PLANES, ENGINE, AND KEEL.

Depress the hatch safety switch, shift to forward, and check propeller rotation and console indication.

Shift to neutral.

When propeller has stopped, shift to reverse, and check propeller rotation and console indication. The console will momentarily indicate forward, and then give a steady indication of reverse.

Shift to neutral and release the hatch safety switch.

Increase the throttle to 1000 RPM.

2.4 Shut off engine with the console stop switch and check:

foreplanes full rise
aftplanes full pitch up
lower mast valve closed
fuel feedback off

2.5 Restart the engine, press the EMERGENCY STOP BUTTON, and check:

foreplanes full rise
aftplanes full pitch up
lower mast valve closed
fuel feedback off
depth setpoint has changed to -4.0. Pitch setpoint has changed to 25.
reset the depth and pitch to 0.

2.6 Record: (not running) Console

engine battery volts _____
electronics battery volts _____

3-BALLAST SYSTEM

3.1 Turn the AIR ENABLE VALVE ON--SLOWLY-- and OFF and check:

hp air pressure console _____

vehicle _____

Note: The console reading should be within \pm 100 psi of the vehicle reading, otherwise check the calibration of air pressure transducer.

low pressure air indication on console (Air On Fb)

3.2 Check the vents:

Open the vents and check that they are open and that the console display agrees.

Listen at vents for air leaks.

Close the vents and check that they are closed and that the console agrees.

3.3 Check the blow:

Turn blow on (open) and listen for air being blown into the forward and the aft ballast chambers.

Turn the blow off (close).

3.4 Turn the AIR ENABLE VALVE **ON-- SLOWLY-- and OFF**. Lift the engine room flood switch, and check:

vents are closed

blow is on

console vent, blow, and flood indicators agree

Mast valve closed

Fuel "Off"

- 3.5 Turn the blow **OFF**
- 3.6 Install bilge drain hose in hull penetration and place drain end of hose in catch bucket. Check operation of the bilge pump by pouring approximately a gallon of water into the bilge on the fuel pump side. Confirm that the console indication agrees and that the pump turns off when the water has been completely pumped from the bilge.
- 3.7 Check that the bilge is dry .
- 3.8 If the electronics compartment is open, check the wet alarms by holding a wet finger across the probes. Confirm **Electronics flood** allarm.
- .9 Have someone blow on depth transducer hole and verify the depth increases then returns to 0.

4-BELLYPACK

[]checked

[]not checked

- 4.1 Transfer control to bellyback.
- 4.2 Check the Rudder and RPM control status on the console mode indication on the status page are BELLYPACK.
- 4.3 Start the engine.
- 4.4 Check that the throttle control operates correctly.
- 4.5 Check that the rudder operates correctly.
- 4.6 Make sure all personnel are clear of the propeller, decrease RPM to idle, depress the hatch safety switch, and check that the transmission operates correctly.
- 4.7 Stop the engine.
- 4.8 Return control to the console if necessary.

5-FINAL PREPARATION

5.1 Electronics hatch

Check security of electronic boxes and cables.

Check around and under gasket for foreign objects.

Apply thin coat of silicone grease to electronics hatch gasket.

Close the hatch and tighten the hold-down nuts until there is contact between the top surface of the hinge toggle body and the lower surface of the bridge on the upper lugs. Check both sides of hatch.

5.2 Engine hatch

Remove all tools and loose objects

Check around and under gasket for foreign objects. Ensure that the lifting shackles are clear of the seal area.

Apply thin coat of silicone grease to engine hatch gasket.

Close the hatch and tighten the hold-down nuts until there is contact between the top surface of the hinge toggle body and the lower surface of the bridge on the upper lugs. Check both sides of hatch.

5.3 Fill or top fuel as required and check that fuel cap is tight.

5.4 Ensure that the drop weight safety pin is removed (for transport only).

5.5 Check that the vents are closed and the blow is off (closed).

5.6 Prepare for launch. Switch to BELLYPACK control if necessary.

Note: If the vehicle will not be launched within 1/2 hour, turn the AIR ENABLE VALVE off, then turn the vehicle off to conserve the batteries. Alternatively, start the engine periodically until launch to charge the batteries.

5.7 Final Steps

Ensure hull switch is ON

Ensure air is ON

Ensure safety pin in drop weight mechanism has been removed.

8-LAUNCH PROCEDURE

Exercise care and follow standard safety procedures for lifting and rigging during launching. Procedures will vary depending on available equipment.

8.1 Lift

Attach tag lines and lift sling to Vehicle.

Attach crane hook to sling, ensuring that the crane lines do not foul the mast head fairing.

Lift vehicle and lower into water, using two personnel on the tag lines to control the orientation of the vehicle.

8.2 Launch

When the vehicle starts to float, the lift sling will go slack. Have personnel (wearing life jackets) board vehicle to release forward sling hook and aft shackle.

Ensure that the vehicle power is "on" and the AIR ENABLE VALVE is "on".

DO NOT RUN ENGINE WHILE PERSONNEL ARE ABOARD VEHICLE

Allow all personnel to get off the Vehicle. Move crane hook and slings clear of mast head.

Shift transmission to NEUTRAL. Set heading mode to RUDDER (MANUAL).

Start engine. Reduce RPM to idle.

Clear console alarms. If alarms persist, recover vehicle and rectify problem.

8.3 Release

Release tag lines and maneuver Vehicle with boat hooks until planes are clear of dock, pilings, or mothership.

Ensure Vehicle has adequate headroom.

Shift Vehicle into gear and drive to clear area with at least 25 feet water depth.

Open vents. Set depth and pitch.

Carry out mission.

9-RECOVERY PROCEDURE

Exercise care and follow standard safety procedures for lifting and rigging during recovery. Procedures will vary depending on available equipment.

9.1 Docking:

Drive Vehicle to clear area. Reduce RPM to idle. Shift to NEUTRAL>

Close vents. Blow air (open BLOW) 5 to 10 seconds.

Maneuver Vehicle to recovery site, with engine at idle, using transmission and rudder appropriately.

Attach tag lines to forestay and exhaust stabilizer.

Shift Vehicle to neutral and shut off engine.

9.2 Recovery

Maneuver Vehicle to final recovery position using tag lines and boat hooks.

DO NOT RUN ENGINE WHILE PERSONNEL ARE ABOARD VEHICLE

Have personnel (wearing life jackets) board RMOP Vehicle. Lower lifting gear and attach appropriately, ensuring that the lifting lines do not foul the mast head.

Take tension on the lift sling. Have all personnel get off of Vehicle.

Open the vents. Lift Vehicle clear of water and allow all water to drain from the flooded compartments.

Lift Vehicle on to cradle, with tag line tenders controlling the orientation of the vehicle during lift.

Turn the AIR ENABLE VALVE "off".

Turn the vehicle power "off".

10-POST-DIVE PROCEDURES AND CHECKS

Fresh water wash entire hull.

Fresh water wash exterior sensors and camera.

Check for signs of physical damage to vehicle.

Open access hatches for aftplanes and foreplanes. Apply WD-40 or equivalent to cylinder pins and hall effect pins on rudder, aftplanes and foreplanes.

Open engine hatch. Apply WD-40 or equivalent to throttle actuator ball thread (if electrical throttle is installed), bilge pump bearings, fuel on/off solenoid and linkage, lower mast valve solenoid and linkage, and transmission shifter linkage.

Check integrity of engine room, and for damaged or loose parts, oil leaks, and signs of excessive heat.

Open electronics hatch. Check for signs of leakage (water on floor). Check integrity and

security of boxes and payload.

Prepare for next mission if immediate, otherwise secure all hatches and stow vehicle.

Hydrographic Pre-Dive Checklist

System Startup

Turn on Hydro station equipment:

 Sun Workstation

 OPU Monitor

 OPU

 Arlan Radio

Turn on ORCA equipment:

 Communications Equipment

 Sun Workstation

 Simrad equipment

Log in as "survey"

Launch HydroMap

Set the Job Directory to a temporary dir (/tmp)

Set survey parameters:

 Set all values on window to appropriate values

 Set projection appropriately

Verify Arlan Radio Link

Startup Remote Ping

Verify response from remote system

Startup the real-time system

Startup the DSM interface

Display Hardware Configuration

EM 950 / EM 1000:

Setup OPU:

 Set time and date to 30 seconds BEHIND current UTC time

 Setup TRU simulator

 Set Max Depth > 100m

 Turn transmitter on

- Verify profiles on OPU
- Verify data on the bathymetry waterfall on the Sun
 Log data to a file
- Verify that sidescan and bathymetry show within 5 seconds.

Remote Primary GPS (ORCA)

- Verify that the DSM interface shows proper position
- Verify that the OPU show proper position
- Verify that Messages window shows navigation packets (n's)
- Verify proper location of the ORCA symbol on Coverage Map

Secondary GPS (Mother Ship)

- Check for proper location of the ship symbol on Coverage Map

Ship Compass

- Verify proper orientation of the ship symbol on Coverage Map

Remote Compass

- Verify proper orientation of the ORCA symbol on Coverage Map
- Verify the heading on the rt-console
- Verify the heading on the OPU

Remote TSS Sensor

- Verify the values on the TSS stripchart window
- Verify the roll, pitch, and heave on the OPU

Remote Surface Velocimeter

- Verify the temperature on the Remote Velo window
- Verify that the sound velocity on the Remote Velo Window and the Transducer sound velocity on the OPU match.

RTCM

- Verify that the DSM is providing DGPS positions

ADCP

- Run bbtest to verify communications
- Run transvect
- Verify roll and pitch
- Verify gps position
- Verify heading
- Verify temperature

ASCS

- Verify communications between topside and bottom side PC's

Wesmar Sonar

- Verify pinging and scanning from the Wesmar topside interface

Full System

Exit the real-time system.

Set the Job Directory for the current job

Restart the real-time system.

After Sub is in water:

 Turn TRU high voltage on.

 Turn TRU simulator off.

 Set OPU parameters appropriate for current water depths

- Verify that the Simrad is tracking bottom.
- Verify the Salinity values after the sub is submerged and underway.